## CLAIMS

1. A reforming apparatus comprising an integrated structure of three separate units, which comprises:

a raw material reforming unit for steam-reforming a raw material to be reformed and producing a reformed gas containing hydrogen as a principal component, including a heat source that generates heat by combustion of a fuel gas, operable to directly obtain heat for the steam reformation reaction from said heat source;

a shift reaction unit for decreasing CO contained in the reformed gas, that was produced in said raw material reforming unit, by water-gas-shift reaction; and

a CO oxidation unit for further degreasing CO contained in the resultant reformed gas, that was treated in said shift reaction unit, by oxidation,

said raw material reforming unit, said shift reaction unit and said CO oxidation unit being arranged in a manner that said shift reaction unit and said CO oxidation unit can be indirectly heated by heat transfer from the heat source of said raw material reforming unit.

2. The reforming apparatus according to claim 1, wherein said raw material reforming unit, said shift reaction unit and said CO oxidation unit are concentrically arranged relative to each other with at least said CO oxidation unit placed on an outer peripheral side of the reforming apparatus.

3. The reforming apparatus according to claim 2, wherein said raw material reforming unit comprises a generally cylindrical combustion chamber as the heat source and a reforming reaction unit for steam-reforming the raw material to produce the reformed gas, containing hydrogen as a principal component, said reforming reaction unit, said shift reaction unit and said CO oxidation unit are concentrically arranged relative to said combustion chamber.

4. The reforming apparatus according to claim 3, wherein said reforming reaction unit is concentrically accommodated with said combustion chamber.

5. The reforming apparatus according to claim 3, wherein said reforming reaction unit is arranged around said combustion chamber in contact therewith.

A 6. The reforming apparatus according to ~~any one of claims 3 to 5~~ claim 5, further comprising an incombustible core arranged at the center of said combustion chamber.

A 7. The reforming apparatus according to claim ~~5 or 6~~ 3, wherein both of said shift reaction unit and said CO oxidation unit are arranged around said reforming reaction unit.

~~8~~ 7. The reforming apparatus according to claim ~~7~~ 6, further comprising a partition wall having a function of regulating heat transfer, the partition wall being interposed between said reforming reaction unit and both of said shift reaction unit and said CO oxidation unit.

A ~~9~~ 8. The reforming apparatus according to claim ~~7 or 8~~ 6, wherein said reforming reaction unit and said shift reaction unit are connected by a flow path detouring outside both of said shift reaction unit and said CO oxidation unit.

A 10. The reforming apparatus according to ~~any one of claims 7 to 9~~ claim 7, wherein said shift reaction unit is arranged on a side adjacent to a high temperature zone of said reforming reaction unit and said CO oxidation unit is arranged on a side adjacent a low temperature of said reforming reaction unit, so as to be in conformity to a temperature distribution within said reforming reaction unit.

11. The reforming apparatus according to ~~any one of claims 1 to 6~~ claim 1, wherein said shift reaction unit and said CO oxidation unit are respectively arranged in a position which is heated by a burned exhaust gas from said heat source of said raw material reforming unit.

A 12. The reforming apparatus according to ~~any one of claims 3 to 6~~ claim 3, further comprising an exhaust chamber, in which a burned exhaust gas from said combustion chamber directly flows, wherein said exhaust chamber is positioned adjacent to and coaxially above said combustion chamber, said shift reaction unit

being arranged around said exhaust chamber, said CO oxidation unit being arranged around said shift reaction unit.

13. The reforming apparatus according to claim 12, further comprising an air intake for introducing fresh air in between said combustion chamber and said exhaust chamber.

14. The reforming apparatus according to claim 12 ~~or 13~~, further comprising a secondary heating means for heating said exhaust chamber.

15. The reforming apparatus according to claim 12 ~~any one of claims 12 to 14~~, further comprising an exhaust vent for discharging the burned exhaust gas in said exhaust chamber to the outside, a shutter means for selectively opening and closing said exhaust vent, a first duct which is separated from said exhaust chamber and interposed between said shift reaction unit and said CO oxidation unit, and a second duct which is fluid-connected with said first duct and arranged around said CO oxidation unit.

16. The reforming apparatus according to claim 15, further comprising an air intake for introducing fresh air into said first duct.

17. The reforming apparatus according to claim 12 ~~any one of claims 12 to 16~~, further comprising an incombustible core arranged at the center of said exhaust chamber.

18. The reforming apparatus according to claim 3 ~~any one of claims 3 to 17~~, wherein at least one of said reforming reaction unit, said shift reaction unit and said CO oxidation unit is provided on a surface thereof with a heat transfer material having a higher heat conductivity than that of a material composing of said surface.

19. The reforming apparatus according to claim 3 ~~any one of claims 3 to 18~~, wherein said CO oxidation unit has an outer surface thereof provided with fins for heat dissipation.

20. The reforming apparatus according to claim 3 ~~any one of claims 3 to 6~~, further comprising a main exhaust chamber in which a burned exhaust gas from said combustion chamber directly flows, a main exhaust vent for directly discharging the

burned exhaust gas in said main exhaust chamber to the outside, a shutter means for selectively opening and closing said main exhaust vent, a first duct which is separated from said main exhaust chamber and fluid-connected thereto and is arranged around said main exhaust chamber, and a second duct which is fluid-connected with said first duct and arranged around said first duct, said shift reaction unit being placed in said first duct, said CO oxidation unit being placed in said second duct.

21. The reforming apparatus according to claim 20, further comprising an exhaust sub-vent for discharging a burned exhaust gas within said first duct to the outside, and a shutter means for selectively opening and closing said exhaust sub-vent.

22. The reforming apparatus according to claim ~~20 or 21~~, wherein at least one of said reforming reaction unit, said shift reaction unit and said CO oxidation unit is formed into a coil-like shape.

23. The reforming apparatus according to ~~any one of claims 20 to 22~~, further comprising an air feed channel for introducing fresh air into said second duct.

24. The reforming apparatus according to ~~any one of claims 1 to 23~~, wherein at least a portion of a raw material feed channel for feeding the raw material and steam to said raw material reforming unit is arranged in a position in which the raw material and the steam are preheated by heat from the heat source of said raw material reforming unit.

25. The reforming apparatus according to claim ~~24~~, wherein at least a portion of said raw material feed channel is held in contact with the surface of at least one of said reforming reaction unit, said shift reaction unit and said CO oxidation unit.

26. The reforming apparatus according to claim ~~24~~, wherein at least a portion of said raw material feed channel is arranged at a position able to be contacted with the burned exhaust gas from the heat source of said raw material reforming unit.

27. The reforming apparatus according to claim ~~24~~, wherein at least a portion



460

of said raw material feed channel is arranged at such a position that it can be directly heated by the heat source of said raw material reforming unit.

28. The reforming apparatus according to ~~any one of claims 1 to 27~~ claim 1, wherein at least a portion of a fuel feed channel for feeding fuel to the heat source of said raw material reforming unit is arranged at a position able to be preheated by heat from the heat source of said raw material reforming unit.

29. The reforming apparatus according to ~~any one of claims 1 to 28~~ claim 1, further comprising a combustion catalyst held in said heat source and a preheating means for preheating the combustion catalyst, wherein the heat source of said raw material reforming unit generates heat by catalytic combustion.

30. A reforming apparatus comprising an integrated structure of four separate units, which comprises:

a combustion unit for generating heat by combustion of a fuel gas;

a reforming reaction unit for steam-reforming a raw material and producing a reformed gas containing hydrogen as a principal component;

a shift reaction unit for decreasing CO contained in the reformed gas, that was produced in said raw material reforming unit, by water-gas-shift reaction; and

a CO oxidation unit for further degreasing CO contained in the resultant reformed gas, that was treated in said shift reaction unit, by oxidation,

said reforming reaction unit being directly heated by said combustion unit so that the temperature in said reforming reaction unit is controlled in the range of 400 to 1000°C, said shift reaction unit being indirectly heated by heat transfer from said combustion unit so that the temperature in said shift reaction unit is controlled in the range of 200 to 350°C, said CO oxidation unit being indirectly heated by heat transfer from said combustion unit so that the temperature in said CO oxidation unit is controlled in the range of 100 to 250°C.